

Buying Bitcoin - When The Low Comes Before The High

Overview:

- **Inspiration**
- **Data**
- **Model**
- **Results**
- **Future Work**

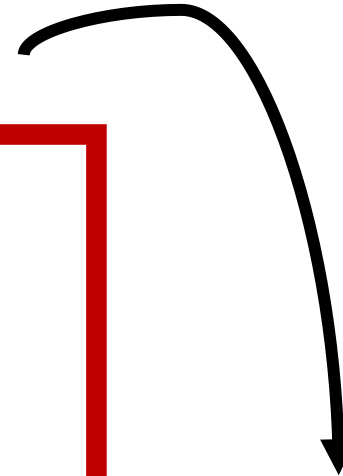
Hope this pic inspired you



Actual Inspiration and Intuition

In a Past Project (similar stock predictions)

- Using:
 - Price History
 - Quarterly Financial Statements
 - Insider Trading History



Good for timing/trend indicator of a company's stock price

The Question: Can the same be done for cryptocurrency

Can predictions be made without fundamentals?

Kind of...

- **Things to keep in mind:**
 - **Stocks have metrics which investors take very seriously**
 - **Cryptocurrencies have no fundamental value**
 - **Some cryptos are tied to real economic value (compute services)**
 - **No standard method of comparing this real value provided and its relative worth to a “stable coin” like Bitcoin**

An Aside: Universal Price Formation Patterns in Order Books**

Credit where it is due. A lot was learned from this paper

- **Data**
 - **Billions of sequential orderbook**
- **Goal**
 - **Prediction of next tick direction**
- **Findings**
 - **Universal patterns between industry and time periods on out of sample data**
 - **Analogous to language modeling**

**** Citation:**

Justin Sirignano & Rama Cont (2019) Universal features of price formation in financial markets: perspectives from deep learning, Quantitative Finance, 19:9, 1449-1459, DOI: [10.1080/14697688.2019.1622295](https://doi.org/10.1080/14697688.2019.1622295)

The data...



BitMEX Exchange – What's Available

Field	Description
• timestamp	- time (microsecond)
• symbol	- contract (exchange handles more than BTC)
• Side	- buy/sell
• size	- # of contracts = USD
• Price	- Price of Contract
• tickDirection	- ['MinusTick', 'ZeroMinusTick', 'ZeroPlusTick', 'PlusTick']
• grossValue	- Number of satoshis 1 satoshi = 0.00000001 units
• Home Notional	- # of coin
• Foreign Notional	- # of US dollars

How Data Is Used

Field	Description
• timestamp	- Collect trades into 1 minute intervals for analysis
• symbol	- include trade in analysis
• Side	- buy/sell. Important filter for other metrics
• size	- Summary statistics based on volume
• Price	- Price of Contract
• Tick Direction	- Counts per time period (inspired by price formation paper)

Further Processing

- **Returns Relative to Prior VWAP**

$$\text{Minute_Min_Vs_VWAP} = \frac{\text{PriceMin}_t - \text{PriceMin}_{t-1}}{\text{VWAP}_{t-1}}$$

- **Returns Relative to Own Metric**

$$\text{Minute_Min_Vs_Self} = \frac{\text{PriceMin}_t - \text{PriceMin}_{t-1}}{\text{PriceMin}_{t-1}}$$

- **About 40 variations experimented with... kept 10 most valuable**



The Model...

Scenario: Base Case

Operating Options

- Construction period (Months): 4
- Construction Costs (USD/MW): 772.5
- Energy Production Scenario: P
- Feed in (USD/MWh): 130
- Inverter Placement (Year): 13
- O&M Expenses (USD/kWh): 18.00
- Inflation Index for O&M Cost: Base inflation
- Performance Ratio: P50
- Degradation: 0.50%

Financing Structure

- Debt Sizing: Gearing
- DSCR Target: 1.30
- Gearing Ratio: 0%
- Repayment Method: Sculpting
- Funding Method: Pro-Rata
- Debt Tenor in Years: 10
- Capitalise Interest: FALSE
- DSRA: 6
- Cash Sweep Percent: 0%
- DSCR Covenant: 1.2

Re-financing

- Include Re-Financing: FALSE
- Year of Re-Financing: 4
- Re-financing Target DSCR: 1.16
- Re-financing Tenor: 16 (Too Long)
- Re-financed Debt: 872.86

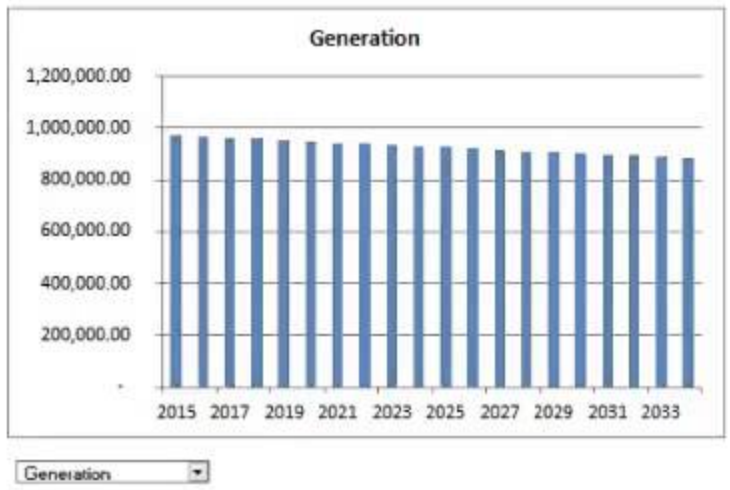
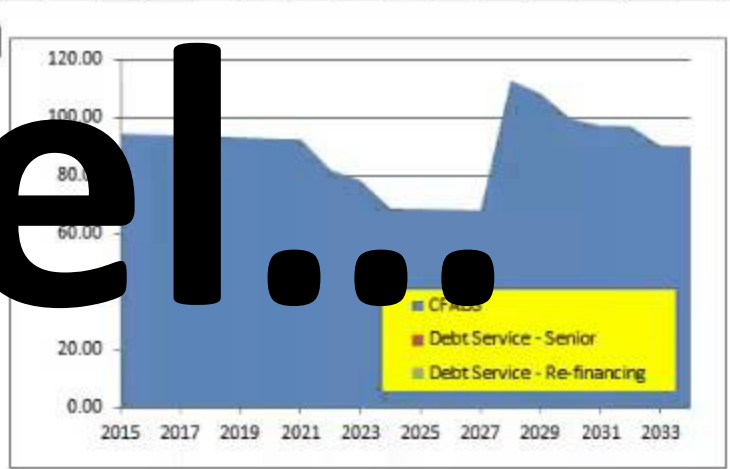
Model Mode: Structuring Risk Analysis Fix Debt

	Nominal	Real	MIRR
Project	7.84%	7.84%	7.84%
Debt before tax	FALSE	SE	-100.00%
Debt after tax	FALSE	SE	-100.00%
Equity	7.42%	5.41%	7.00%

	Initial Debt	Re-Finance
Minimum DSCR	0.00	0.00
LLCR	0.00	0.00
PLCR	0.00	0.00

	Amount	Percent	Per kW
Uses of Funds			
Construction	878.27	95.20%	1,759.3
Development Cost	44.25	4.80%	88.6
Development Fees	0.00	0.00%	0.0
Interest During Construction	0.00	0.00%	0.0
Total Fees	0.00	0.00%	0.0
DSRA	0.00	0.00%	0.0
Total	922.52	100.00%	1,848.0
Sources of Funds			
Debt	0.00	0.00%	0.0
Equity	922.52	100.00%	1,848.0
Total	922.52	100.00%	1,848.0

Model ok	MW	0.4992
Fund MRA	<input checked="" type="checkbox"/>	TRUE



At Midterm Presentation:

Model was too big / looking too far forward

Data Imports as:

~ 500k trades/day

Transformed to:

```
In [93]: df.head()
```

```
Out[93]:
```

timestamp	symbol	side	size	price	tickDirection	trdMatchID	grossValue	homeNotional	foreignNotional
2017-08-18 00:00:01.536113	XBTUSD	Buy	202	4278.3	ZeroPlusTick	fd8cc9de-9e76-a2ce-196c-1e5e64bedeee	4721548	0.047215	202.0
2017-08-18 00:00:01.536113	XBTUSD	Buy	909	4278.4	PlusTick	3c4f3bb7-c431-22b9-033b-4e769b506dce	21246057	0.212461	909.0
2017-08-18 00:00:02.160534	XBTUSD	Sell	398	4278.2	MinusTick	e05c6ef3-ae5b-e001-e253-324ece1b9133	9302852	0.093029	398.0
2017-08-18 00:00:02.160534	XBTUSD	Sell	11643	4278.1	MinusTick	a815b31a-9cfa-b6ef-b2fe-b5c074887561	272155125	2.721551	11643.0
2017-08-18 00:00:02.472558	XBTUSD	Buy	1988	4278.3	PlusTick	f9e800b2-72ff-5e47-9c3f-f789e9ce91ae	46467512	0.464675	1988.0

Observation #	X (features)			Y (target)		
1	x_1	...	x_t	y_{t+1}	...	y_{t+z}
...
n	x_n	...	x_{n+t-1}	y_{t+n}	...	y_{t+n+z}

47 minute lookback

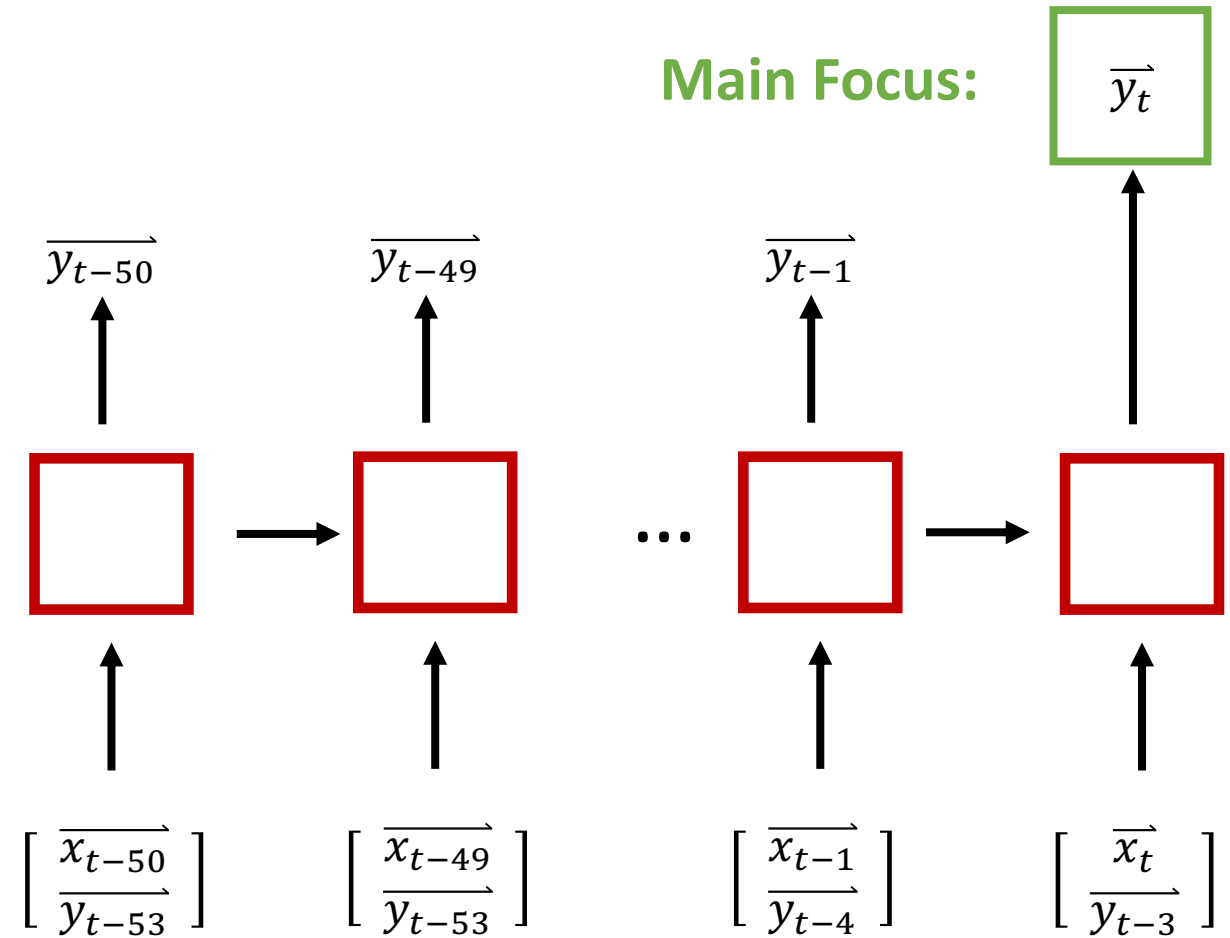
3 minute future prediction

Visualization of Final Model's Flow

Features: $\vec{x}_t \in \mathbb{R}^{21}$

Targets: $\vec{y}_t \in \mathbb{R}^6$

Model Inputs: $\begin{bmatrix} \vec{x}_t \\ \vec{y}_{t-3} \end{bmatrix} \in \mathbb{R}^{27}$



Back to Basics: Summary of How Observations Are Made

	X (features)			Y (target)		
Observation:	x_1	...	x_t	y_{t+1}	...	y_{t+z}

↑
Currently Prices

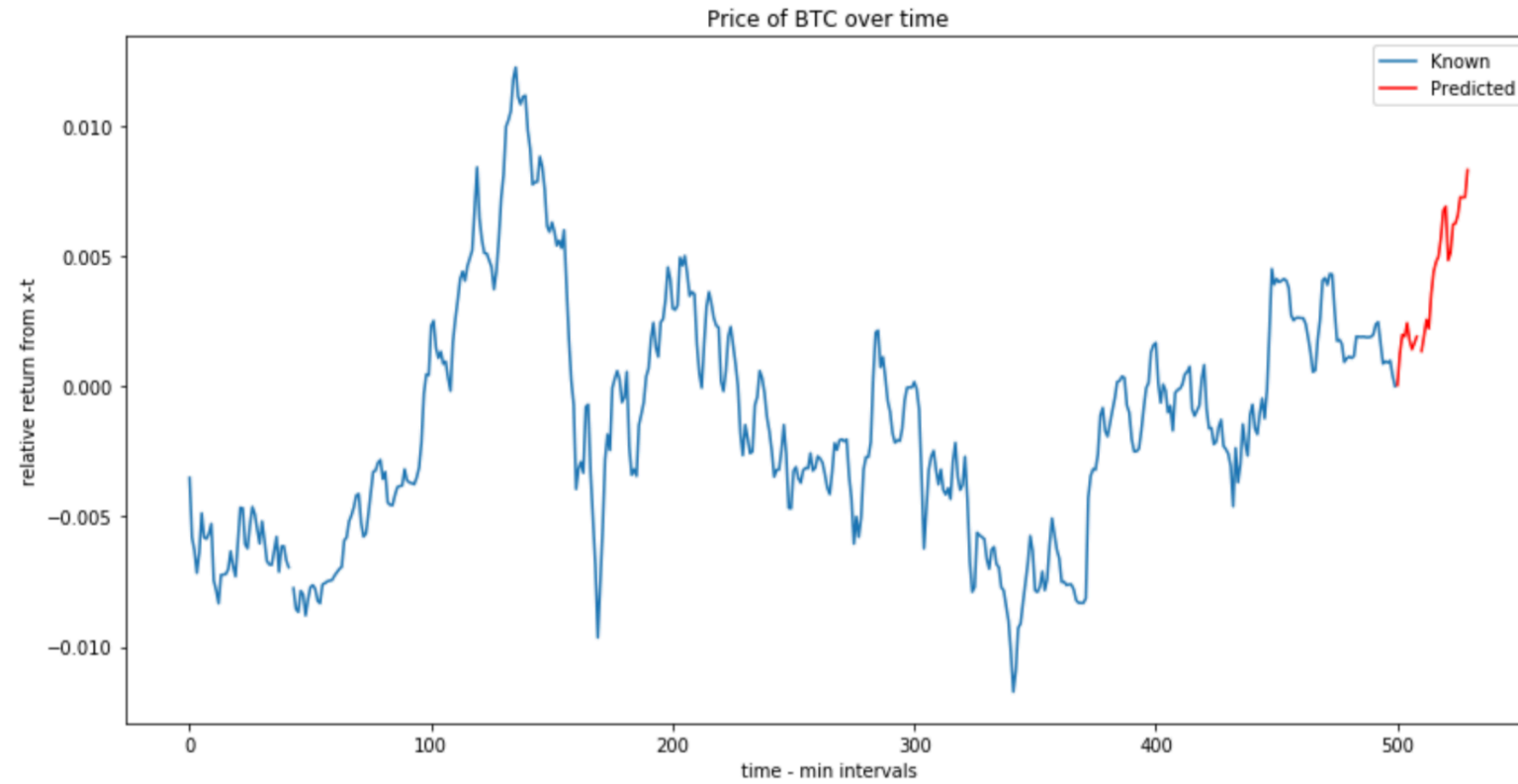
↓
Transform To returns by

	X (features)			Y (target)		
Observation:	$\frac{x_1 - x_t}{x_t}$...	$\frac{x_t - x_t}{x_t}$	$\frac{y_{t+1} - x_t}{x_t}$...	$\frac{y_{t+z} - x_t}{x_t}$

(Last Time) Price Prediction

Primary Goal:

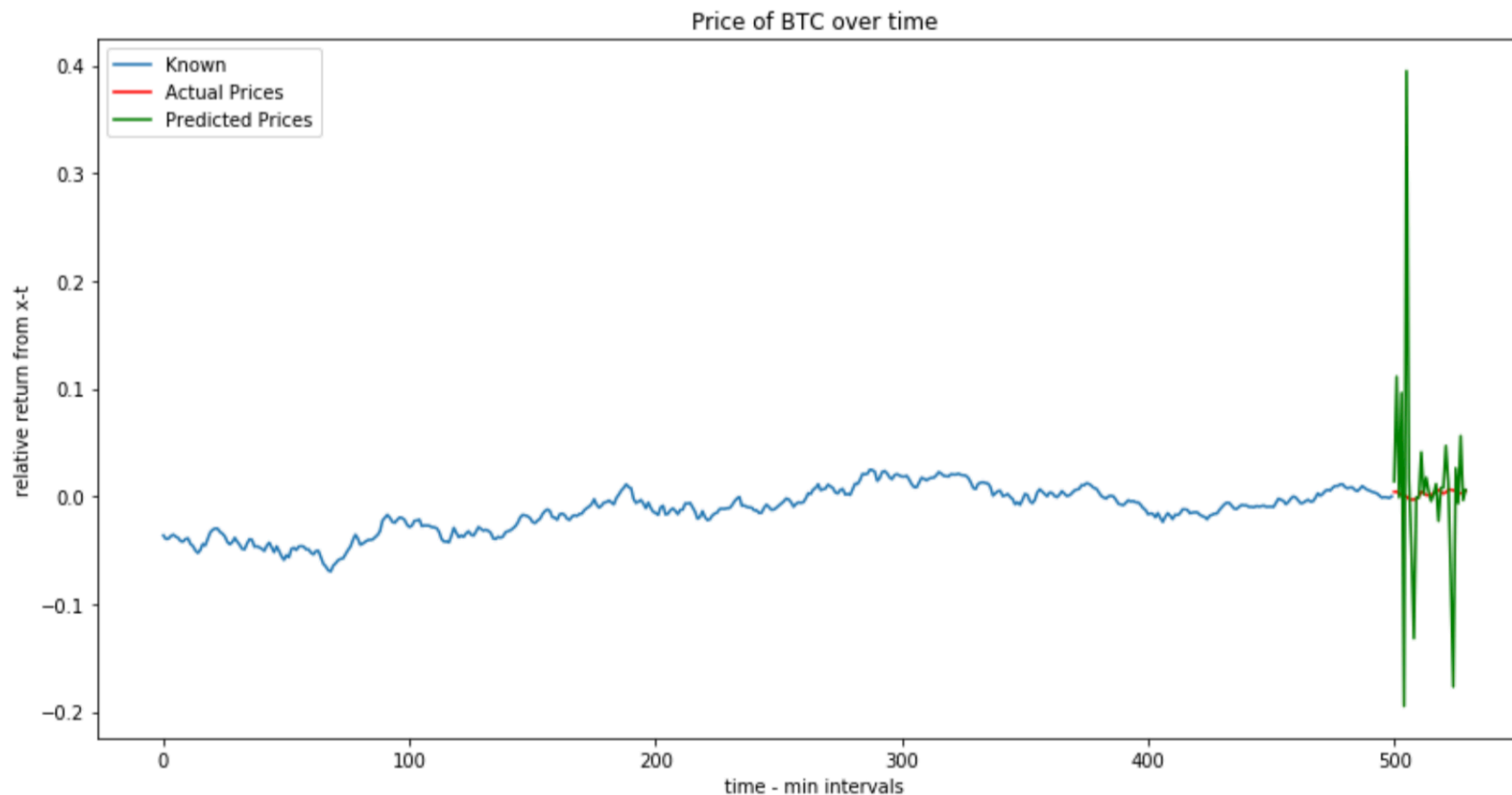
- Predict Future Returns In Short Term



Unfortunately...
LSTMs can be tricky

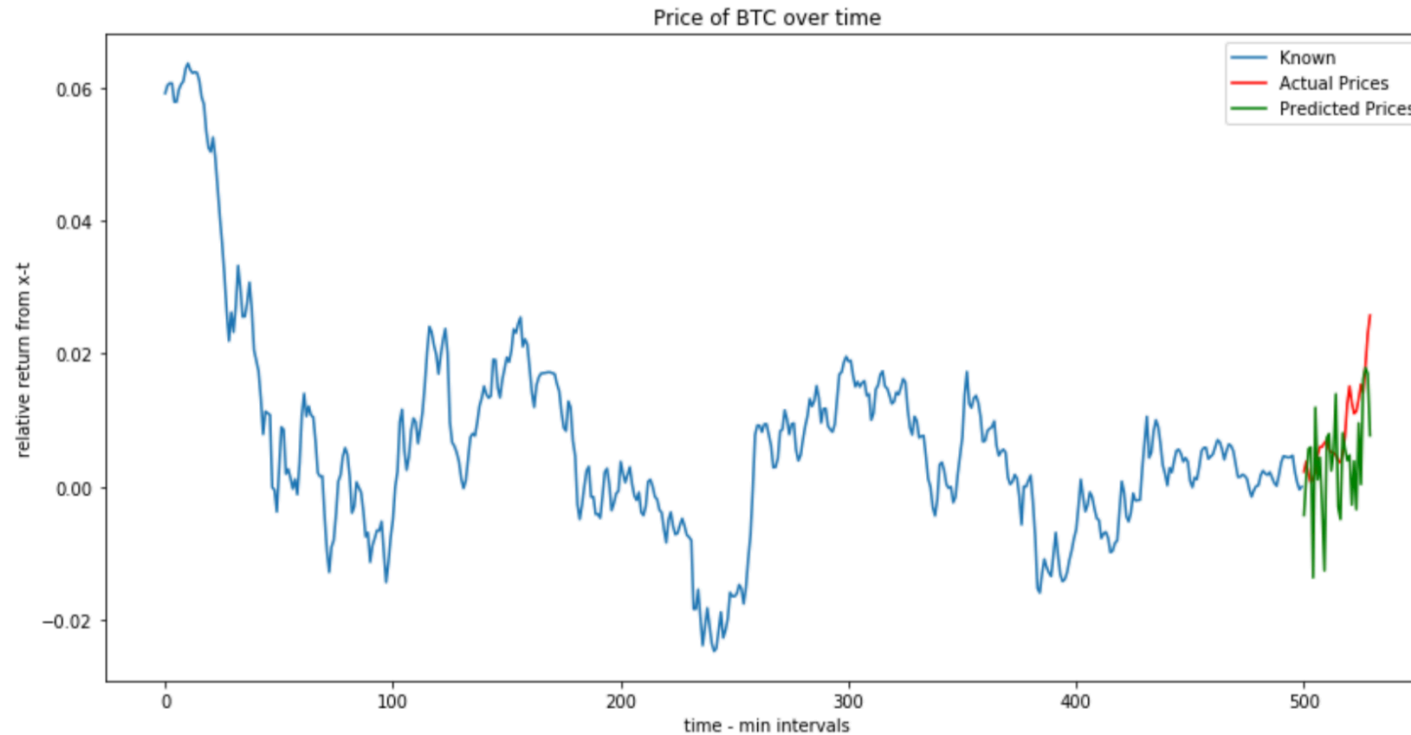
(Last Time) Predictions Have Looked More Like This:

LSTM Predictions... much more volatile than actual prices



(Last Time) With Some Hyper-Parameter Tuning

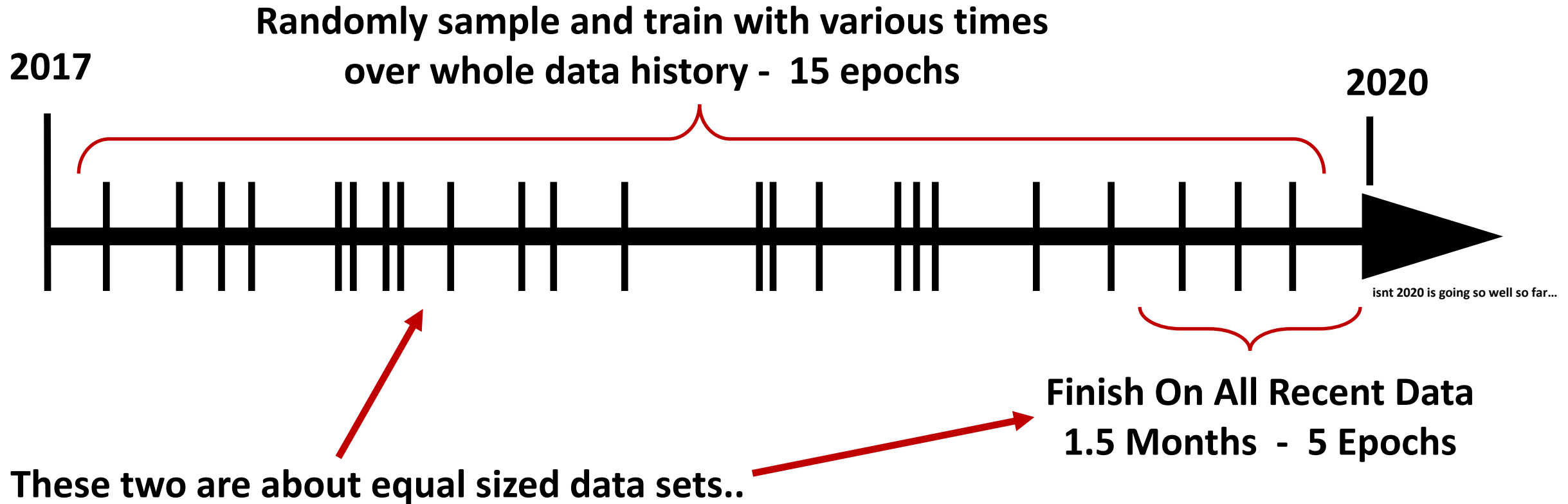
We Can Fix This Problem (slightly)



Prediction volatility persists enough...

Maybe good to explore alternatives to price timeseries forecasting

So What Is Different Now?



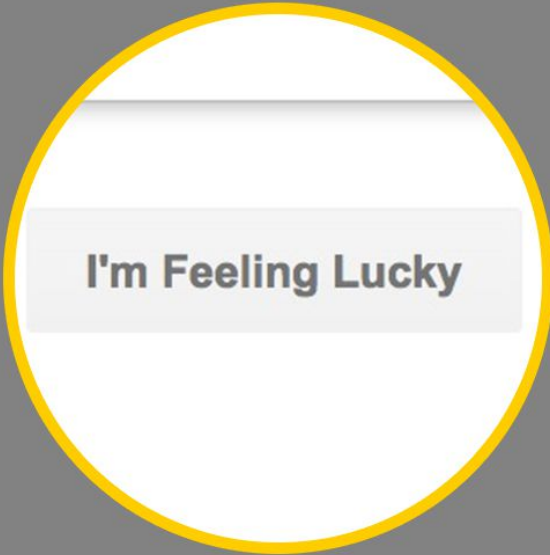
** Inspired by the Universal Price Formation Paper

Results

A search input field with a microphone icon on the right side, indicating voice search functionality.

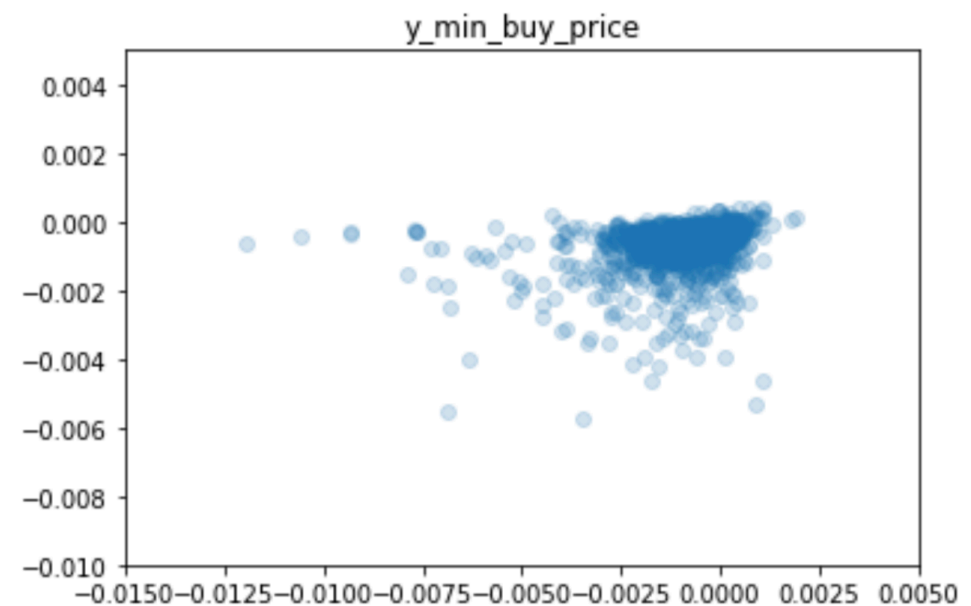
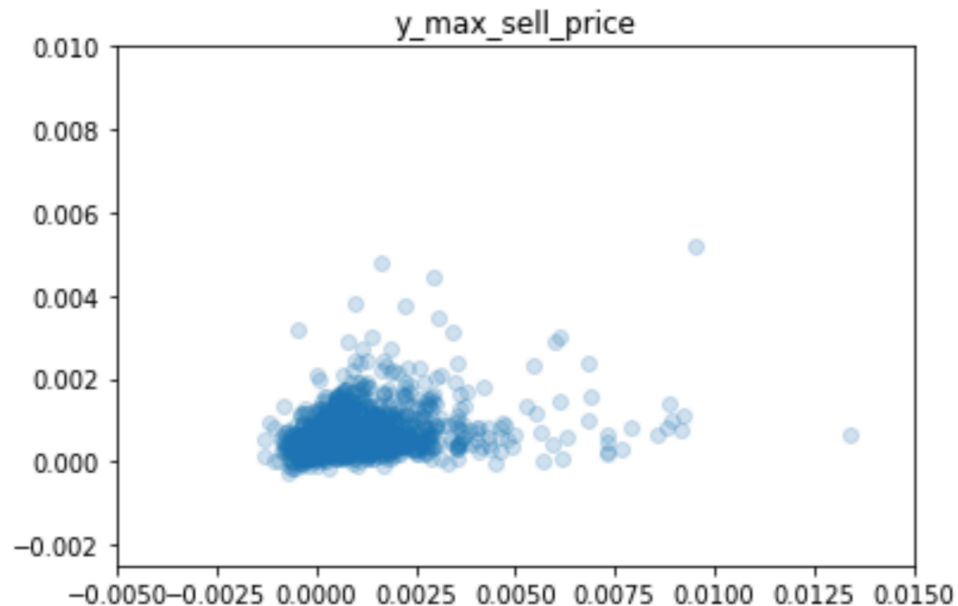
Google Search

I'm Feeling Lucky



Final Version Predictions: Relative Prices

- Given Model Input Observe Final y_t
 - Below: min and max price relative to prior interval's closing price



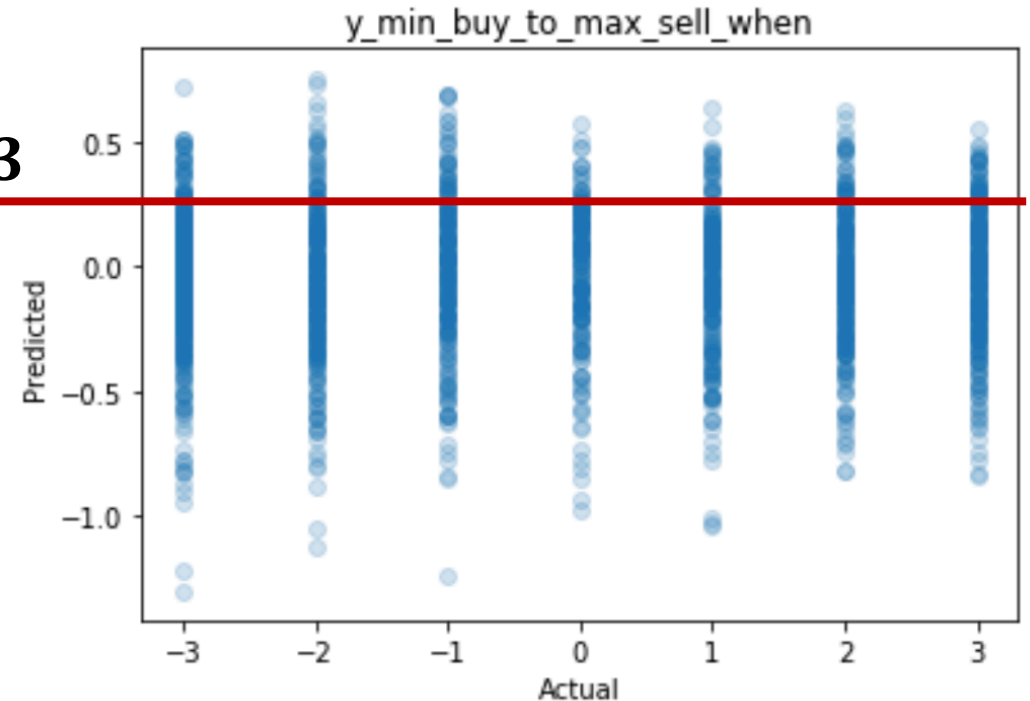
These results look like they could be promising, but they're missing one key factor

Final Version Predictions: Timing

- Initially timing does not seem as useful
- ... combining with some hard-coded rules makes results are more promising

Consider only trades where
predicted min to max timing is
Greater than 0.3...

$$y = 0.3$$

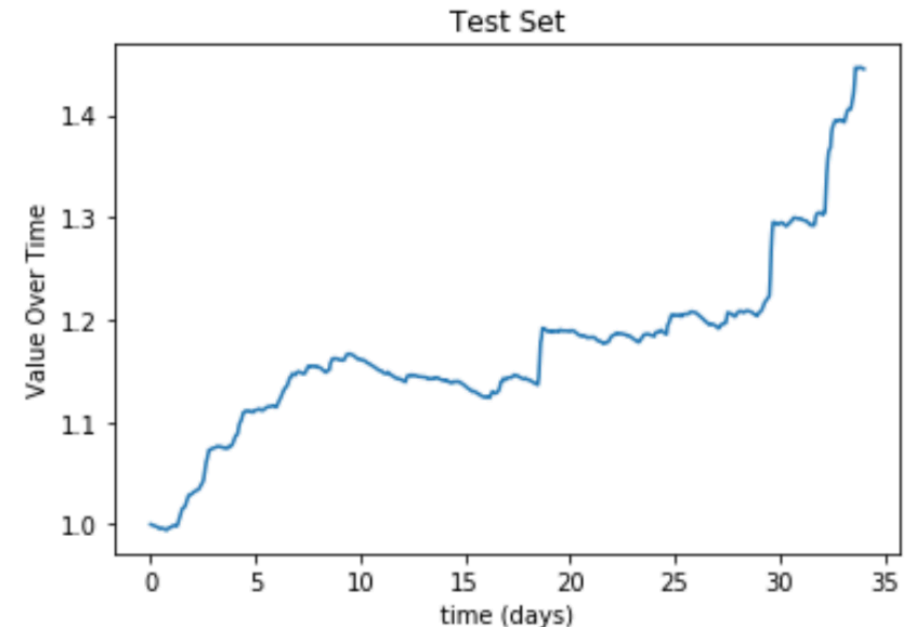


Hard Coding is Important – a typical run

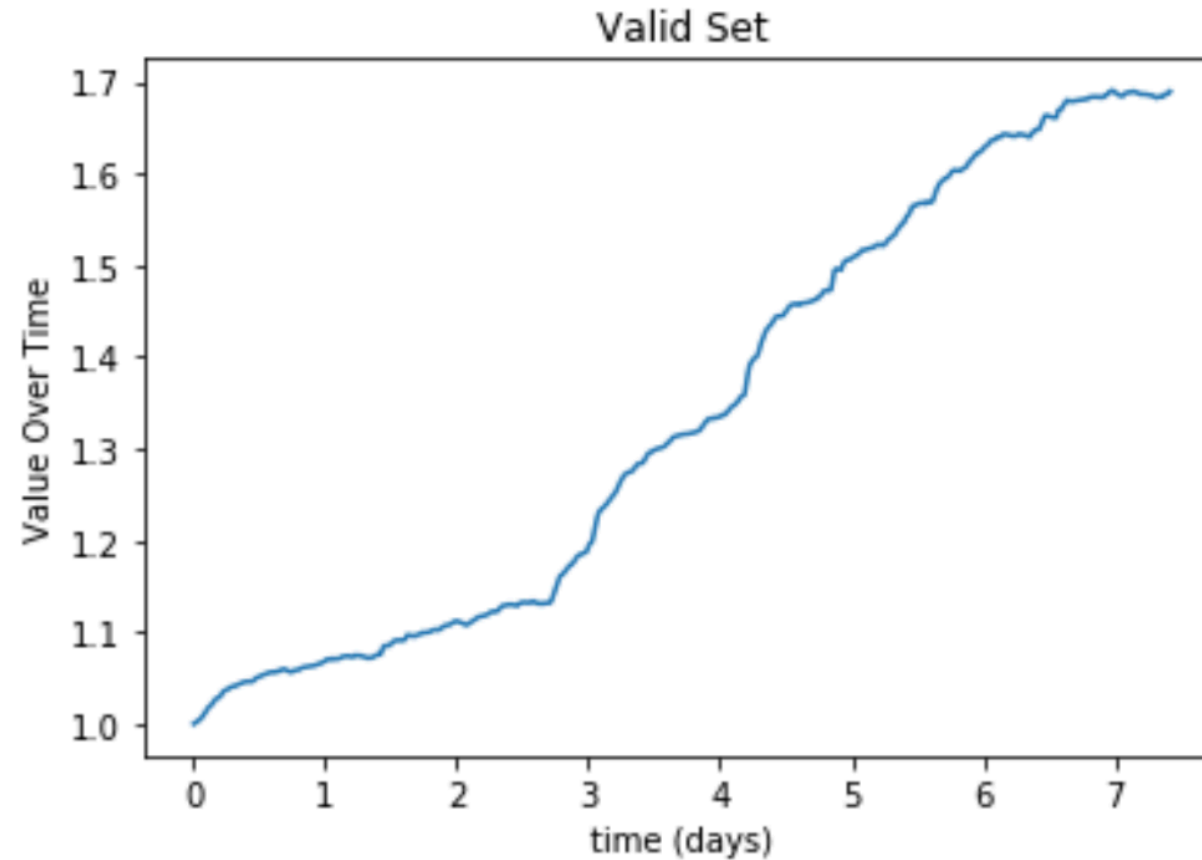
Optimal Procedure from some tuning

- If min to max timing > 0.3
- Place limit order for 0.993 of min prediction price
- Set Immediate Stop Loss of 0.15% on trade (assume if necessary it will hit within 2 ticks on average, a tick is equal to a penny)
- If reaches max predicted price set stop loss at that price, let run till end of 3 minute period.
 - As price rises adjust stop loss up so it hits 3 pennies below current price

Results



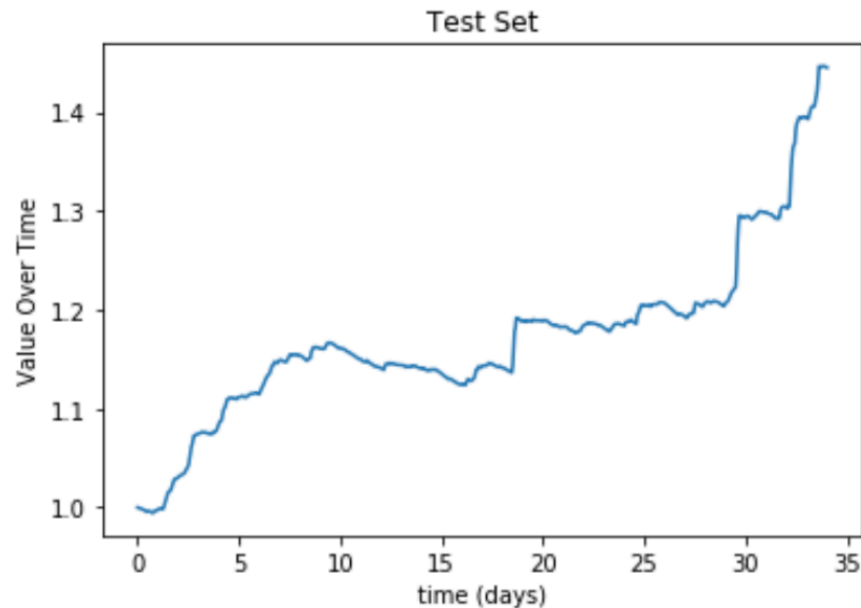
Best Run



If Its too good to be true... On Average Run

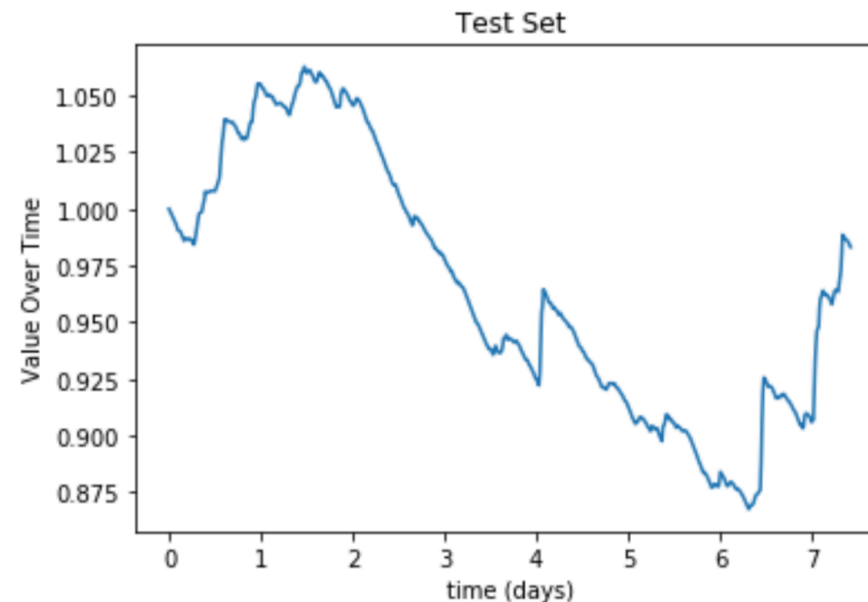
Actual Trading Fees

- $0.000750249 \approx 0.075\%$



Raised Slightly Trading Fees

- $0.0012496 \approx 0.12496\%$

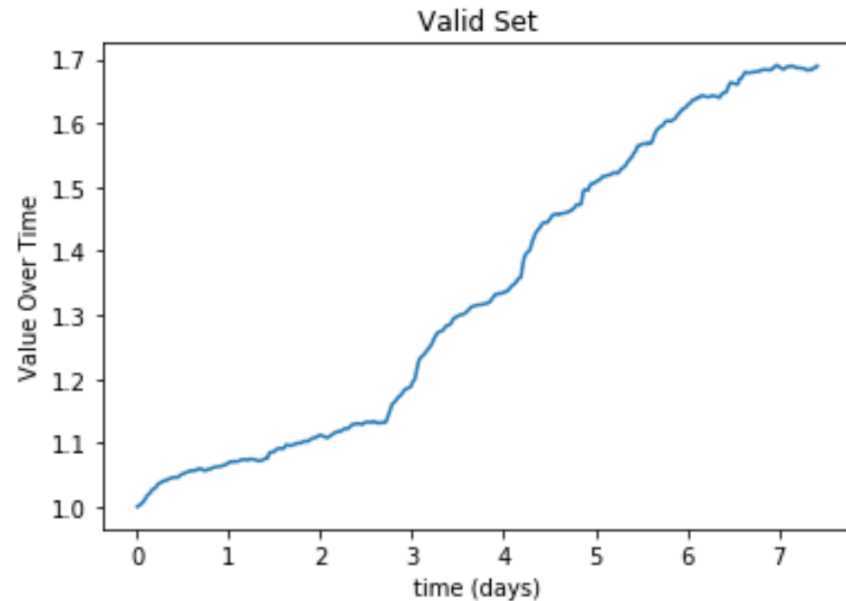


Results will be somewhere in between due to exchange's fee structure

If Its too good to be true... On Best Run

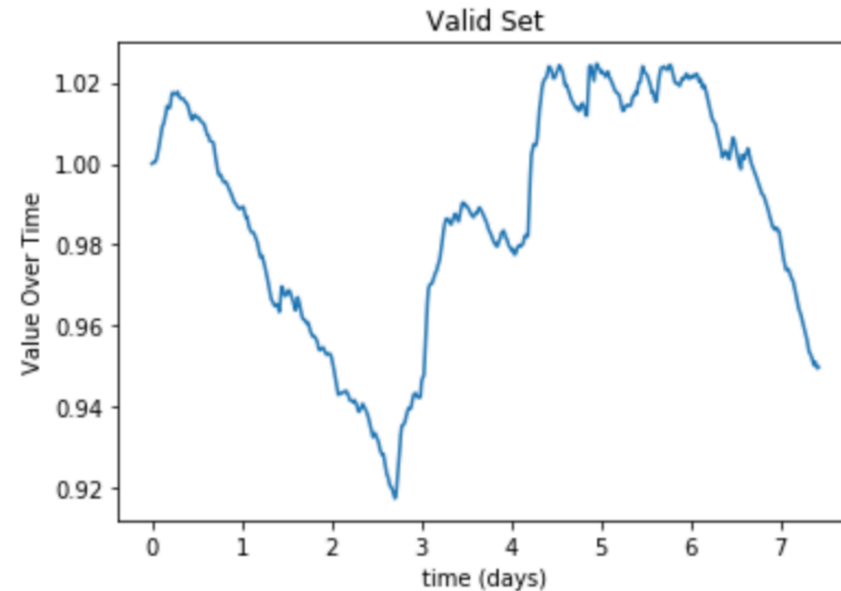
Actual Trading Fees

- $0.000750249 \approx 0.075\%$



Raised Slightly Trading Fees

- $0.0012496 \approx 0.12496\%$



The right side is a worst case scenario under some (hopefully) light assumptions

Summary

Approach / What Worked

- Data Cleaning Process
- Price predictions over time are hard
 - But...
- Current model structure
 - Relative min / max and when a bit easier

Uncertainty

- Are assumptions reasonable
 - Trading fees especially
- Looking at BitMEX volume it seems that hitting within 2 ticks of a set limit is reasonable
- Communication time – due to inexperience your guess is as good as mine